LOCATION OF
RADIO INTERFERENCE
ON RURAL POWER SYSTEMS

REA

U. S. DEPARTMENT OF AGRICULTURE

RURAL ELECTRIFICATION ADMINISTRATION

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September 1950

Prepared By
Technical Standards Division
Rural Electrification Administration
U. S. Department of Agriculture
Washington, D. C.

GPO O REA—175

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PART I

GENERAL

Radio interference on a rural power system is an unnecessary evil, and a symptom of potential line trouble which may sooner or later cause an outage on the circuit. Since the home radio is a major source of news and entertainment for the farm home, toleration of radio interference on the power system by the operating personnel of that system is a sure way to ruin an otherwise good public relations program. A properly organized maintenance program uses radio interference on the system as an indication of potential line trouble and steps are taken to eliminate it at the source as soon as it is detected. The management should not wait until a complaint comes into the office before taking action. Certain of the line trucks should be equipped with suitable detecting apparatus so that noise which may show up on the system can be detected and eliminated during regular system patrols.

Many operators of rural power systems, recognizing this, have requested information on methods and techniques for radio interference location as well as suitable detection apparatus.

Radio noise plagues the operators of all power systems. It is a serious problem in rural areas. Noise signals which would be tolerable in urban areas near large broadcast transmitters, are rapidly attenuated by the relatively heavily loaded feeders. Consequently the area covered by the noise signal is usually quite small and easily searched. The broadcast signals in the urban areas are generally so strong that they override noise to such an extent that the noise is not irritating to the listener.

In rural areas the conditions are generally reversed. The broadcast station signals are relatively weak, the power lines extend for great distances between transformers, taps, etc., and the characteristic impedance of the primary circuit is relatively high (approximately 500 ohms). A noise signal on such a circuit under ideal conditions can disable a sensitive receiver located ten miles from the actual source of the noise signal. Noise signals which originate on a tap can feed into the main line and travel for long distances on each side of the tap junction. In some cases the noise signal is lowest at the tap point and increases on each side of this junction.

The noise rejection characteristics of most home radio receivers sold today are very poor. Many of them are of the so-called ac-dc type with built-in loop antennas and with no pre-selection ahead of the mixer stage. These sets are intended for use in the primary service area of broadcast transmitters and are quite susceptible to noise signals. Many of them, however, are found in rural homes as bedside and kitchen radios. The ac-dc receiver has one side of the ac power circuit connected directly to its chassis, and has no provision for filtering out radio noise which may be conducted over the power circuit into the set. In some cases the reversal of the plug in the wall outlet will place the chassis on the grounded side of the 117

volt supply and reduce noise of the conducted type. These sets are also quite susceptible to radiated interference as they are poorly shielded in their input circuits. In addition, placement of the receiver in the home is more often dictated by the interior decorator of the home than by technical considerations. Loop antennas will not work when placed near window screens, or other metallic objects such as metal lathing and piping in a wall which may shield the loop from the station, but not from a noise signal which may arrive from another direction. In most instances a good outside antenna is a must for receivers located more than 50 miles from a transmitter and will work wonders in improving reception. To reduce noise pickup from power circuits, the antenna should be erected so that it is at right angles to the power circuit and as far away as possible from primary and secondary circuits.

SOURCES OF RADIO INTERFERENCE

Radio noise originates from two sources, the line and from the premises of a consumer because of a defect in an appliance or in his wiring. Appliance noise can easily be isolated in a home by disconnecting suspected equipment item by item and listening for changes in the noise These noises generally are conducted interference and affect consumers connected to a common transformer but do not spread over the system for any great distance. Since this paper is concerned mainly with noise which originates on the primary circuit, secondary noise will not be treated other than to mention appliances which give rise to trouble, and wiring defects.

Appliances

Refrigerators with poor connections between motor and frame.
Electric heating pads without snap-action thermostats.
Light bulbs with small gap in filament.
Early light bulbs with filaments strung on small supports at the end of a small glass rod will affect television receivers, even when the bulb is new.
Poorly shielded or ungrounded ignition transformers on oil burners.
All motor driven appliances with series type motors (vacuum cleaners, food mixers, electric razors, etc.) without suppressors.
Loose connections in wall plugs on appliances.
Thermostats on electric irons.
Electric fences.
Fluorescent and neon lamps with inadequate filtering.

The appliances listed are those which cause the most trouble in the home. The better types of appliances incorporate filters to reduce radio interference and such filters can be connected to others which do not come so equipped. Poor grounds should be corrected on all equipment from the standpoint of safety as well as to reduce interference.

House Wiring

Loose connections in energized conductors as well as in the ground circuit.
Corroded fuse plugs in main distribution panel.
Poor bonding of BX cable in outlet boxes.
BX cable too near plumbing or touching piping.
Defective switches.

This type of noise will be present as long as the circuit in question is in use. It may be isolated by disconnection and tracing on each branch.

Noise Originating On The Power Line

Power line noise can be attributed to three main causes. The first is defective insulation in some piece of apparatus; the second, loose connections in the primary or neutral circuit; and the third, electrostatic leakage from some item of un-

grounded hardware which is too close to a grounded part of the pole assembly. Of these three sources, the third is the most common and the most difficult to locate and will be treated in detail. The principles applying to the tracing of leakage noise will apply to noise of the first two types.

Among the items of line equipment which should be examined for defects in locating noise are:

Loose hot line clamps.
Corroded fuse ferrules in cutout boxes.
Defective lightning arresters (particularly the valve type).
Insulators and transformer bushings.
Defects in internal insulation of transformer.
Loose connections in neutral circuit.
Loose ties on insulators and neutral brackets.
Loose pole hardware.
Insufficient spacing between grounded and ungrounded parts of pole assembly (2" min. for 7.2 kv, 8" min. for 14.4 kv).

Noise from electrostatic leakage is the most common type to be found on the multigrounded neutral type of circuit and is the most difficult to trace. Noise which originates on the primary due to leaky insulators etc. generally dies out within a few spans and is easily found. Noise which arises from electrostatic leakage and which gets into the neutral circuit under some conditions may be detectable for 10 miles on each side of the source. This noise is caused by arcing due to insufficient spacing between some item of ungrounded hardware on the pole which is within the electrostatic field of the primary conductors and some part of the pole assembly which is grounded.

It is important to recognize that any piece of line hardware which is near an energized conductor may pick up enough of an electrostatic charge to spill over a small gap. Cases of interference have been traced to long lengths of barbed wire fencing running for some distance under a power line before coming close enough to a pole down ground to develop a leakage gap. In one case the entire fence acted as an antenna and coupled the signal back into the primary. This noise was detectable for five miles from the source on an auto receiver. Uncompleted underbuild should be tied in on insulators and all wires grounded to the system neutral at several points to prevent possible interference as well as for safety considerations. This precaution will also apply to telephone underbuild which may not have reached the stage of completion where the drainage coils have been installed.

Ungrounded conductors on uncompleted underbuild as well as ungrounded hardware on the pole assembly should be treated with the same care and precautions as energized conductors. A minimum spacing of 2" should be maintained between all ungrounded hardware and grounded pole assemblies (for operating voltages up to 7.2 kv).

One type of leakage noise which is quite common and which puzzles many operators is that which comes from staples on the pole down ground. In some cases staples are driven in near the pole top so that the point of the staple is too near the pole top pin through bolt inside the pole. If the gap is small enough between the staple point and the pole top pin hardware a leakage discharge will occur. The pole top pin, due to the capacity between the pin and the phase wire and its associated tie wires, will develop an electrostatic charge with each half cycle of the supply frequency. This noise is a square wave pulse with a repetition rate of 120 cycles per second. It will generally be most noticeable on the rural system at frequencies near 800 kilocycles due to the configuration of the lines although harmonics are present from 120 cycles up to the 100 megacycle region of the radio frequency

spectrum. The attenuation of the lines generally reduces the higher frequency harmonics so that they do not spread as far as the signals in the broadcast band. Since the single phase rural power line represents a nominal surge impedance of approximately 500 ohms to radio signals, and taps branch off at various positions on the line, making an abrupt change in this characteristic impedance, standing waves will develop on the line which makes location of the true source difficult. The location of these taps will also affect the tuned circuit for the noise signal so that some noise frequencies are damped out while others are accentuated. The length of the discharge gap affects the striking voltage of the arc and thus the width of the square wave which is related to the fundamental frequency of the noise signal. If an examination of this signal is made on an oscilloscope, it will appear as a small spike on the tip of each half cycle of the 60 cycle wave.

The analysis of this leakage noise will apply equally to ungrounded cross arm braces too near ground wires or grounded guys, neutral ground wires too close to phase wire pins on alley arms. It also applies to fuse cutout brackets and lightning arrester brackets too near grounded pole members and similar instances. Use of weather-proof wire for the pole down ground lead may cause trouble in case the staples break the insulation without making solid connection to the copper conductor of the down lead.

The earlier REA type construction where the neutral conductor was carried on a metal bracket instead of a spool insulator gave rise to many cases of radio interference which were difficult to locate. A loose tie on one of these brackets, even though the bracket and its bolt are not grounded at the pole in question will cause a noise signal to develop which will travel over three or four spans. A multiplicity of these noise signals will blanket a wide area. Tightening these ties will eliminate the noise for a short period until conductor vibration loosens the ties again. The permanent cure for this type of noise is the changing out of these brackets for the spool insulator used in later construction, and the use of a copper jumper with appropriate connectors for the connection to the pole ground.

All connections to the neutral or to the pole down ground should be made with jumper wires and connectors. This applies equally to static wires used on transmission circuits. The practice used in some instances, where the pole ground wire is placed under galvanized hardware is unsatisfactory and should be discontinued.

Leakage noise may disappear in wet weather if the pole surfaces are thoroughly wet. The resistance of the water over the pole surface is then low enough to drain off the charge before it can develop to the breakdown potential of the discharge gaps.

Wet weather, however, will increase insulator noise because in this case the pole top pin is grounded by the water over and in the pole and the extra insulation afforded by the pole wood is no longer available. This increases the dielectric stress across the insulator and raises the noise level accordingly.

METHODS OF LOCATION

It should be recognized at the outset that no device has yet been invented which will unerringly locate and identify the source of radio interference. The basic principle of narrowing the search area and isolation of suspected apparatus must be followed in all cases. Success in radio interference location depends upon the acquired skill of the operator in interpreting the readings of his instruments and in recognizing possible source of noise by their characteristic sounds. Appliance noise, particularly from motor driven apparatus is of an intermittent

nature, coinciding with the duty cycle of the defective piece of equipment. Loose connections are most apparent on windy days as is noise caused by tree contact with primary conductors. These are also intermittent in nature. Electric fences have a regular popping sound to them, their frequency governed by the timing apparatus built into the controller. Noise due to insulators and bushings is generally a heavy rasping buzz while the staple and hardware noise is higher pitched.

Phonograph records of various types of appliance noise are available from the Tobe Deutschmann Corporation of Norwood, Massachusetts. These may be useful in training line personnel in recognizing these sounds.

Some cases of interference are easily found by driving along the road with the volume on the locator turned up and the locator tuned to a position on the broadcast band near 800 kilocycles where no broadcast stations appear. When standing waves on the line are not present, the offending pole is easily picked out and can be examined for sources of interference. A useful implement for the detection of loose connections is a sledgehammer for striking suspected poles. If the noise changes with the blow, the struck pole should be examined in detail. A slight delay between the blow and the change in noise indicates adjacent structures.

Standing waves on the line may complicate the location problem. This is characterized by a series of maxima and minima in signal strength as the truck is driven along the line. Peaks in signals appear of equal strength at intervals of 400 to 500 feet for 800 kc and closer together at higher frequencies.

When tracing for noise the distance between the antenna and the line should be taken into consideration when comparing the strength of signal peaks, and signal increases due to overhead guy wires, services and taps should be disregarded. Comparisons of signal peaks can be made easier if the noise is tuned in higher and higher on the short wave bands as the signal strength increases. Since the short wave signals die out faster than the broadcast signals along the line, this technique narrows the search area considerably. When the "hot zone" is located taps should be momentarily disconnected while listening for changes in the signal. If the noise stops the tap should be re-connected and search continued on it. A decrease in the noise upon disconnect may mean that the transmission characteristics of the line have been affected by the removal of the tap and the level of signal thereby altered. The noise, however, is not originating on the tap. After tap isolation has been effected and the noise continues, each pole in the noise zone should be struck with the sledgehammer and subjected to visual inspection. The sledgehammer blow will not affect staple tip noise and some of the other types of interference. It will, however, show up poor connections.

Since the human ear is a poor judge of relative intensity of sounds, a meter for indication of signal level is essential. The radio used for location must have its automatic volume control circuit disconnected.

A useful accessory for probing for defective insulators and bushings is a small neon lamp taped to the end of a hot stick. A small NE 30 or 32 lamp with the base and resister removed may be used. The short wires coming out of the glass bulb should be extended in a manner similar to a rod dipole antenna used in television reception. Each wire should be about 3/4" long. This lamp should glow within three to four feet of a defective insulator or bushing depending upon the severity of the interference signal, while a good insulator will show no indication at from 6 to 8 inches. These distances will, of course, vary with line voltage as well as with the individual lamp used.

This lamp in some cases will show up noise due to poor hardware spacing, but visual inspection of these items is the more reliable method.

REQUIREMENTS FOR A RADIO INTERFERENCE LOCATOR

A radio interference locator suitable for rural power systems should have sufficient sensitivity to detect a signal which will interfere with an automobile radio or a sensitive home receiver. It should be selective enough to find a spot in the broadcast band where the noise can be detected without interference from broadcast signals. It should be capable of tuning over the broadcast band in order to identify signals appearing here which are causing radio disturbances in the area. A desirable feature from the standpoint of the operator is the inclusion of short wave reception up to 20 or 30 megacycles for noise tracing at the higher frequencies as previously described. It should incorporate a meter in the audio circuit which will give the relative levels of noise signals. If the instrument is to be used in a truck for patrolling the line, it should be proofed against ignition interference and tire static from the vehicle. It should be rugged enough to withstand the vibration of the truck without microphonics from the tubes in the receiver. It should have sufficient undistorted power output to drive a loud-speaker with a signal which can be clearly heard above cab noise.

For sections of line on private right-of-way which are inaccessible to the patrol vehicle, the additional feature of portability should be added to the general requirements. The instrument should still be tunable over a wide range of frequencies and should contain its own power supply. This portable instrument will also be useful in tracing noise on secondary circuits and in the homes of consumers where noise may originate.

AVAILABLE LOCATORS

Several makes of radio interference locators are being manufactured for power system operators. The general specifications for three such instruments are given below:

ELTRON RADIO NOISE LOCATOR
Model 117

Eltron Incorporated, Jackson, Michigan. This is a fixed frequency device (460 kilocycles) weighing approximately 16 pounds with batteries, phones, etc. The instrument incorporates a hand held loop and a rod antenna is provided for tracing noise signals. These antennas can be fastened to the top of the patrol truck by means of brackets provided for the purpose.

Further information and price schedules may be obtained from the manufacturer.

SPRAGUE
RADIO INTERFERENCE LOCATOR
Model 302

Sprague Products Incorporated, North Adams, Massachusetts. This instrument tunes from 550 kilocycles to 30 megacycles in four bands. Sensitivity is rated at 5 microvolts for the broadcast band and 2 microvolts for the short wave bands. A built in loudspeaker and a meter are provided for visual as well as aural indication of noise signals. A jack is provided for the use of headphones. A built in rod antenna as well as an auxiliary loop may be used with the instrument and either of these antennas may be mounted on the truck with accessory brackets. The device operates from batteries contained within the case or from the 117 volt line. An auxiliary converter is available for operating the instrument from the 6 volt supply of the truck. The output meter can be switched to indicate the condition of the batteries. Provision is made for the use of the audio circuit,

by means of an auxiliary probe, for locating cable faults by the "growler" method as well as for the detection of strong magnetic fields from defective apparatus within a plant. The weight of the instrument is 25 pounds with accessories.

Further information may be obtained from the manufacturer.

TOBE RADIO NOISE LOCATOR
Model 248

Tobe Deutschmann Corporation, Norwood, Massachusetts. This instrument tunes from 200 kilocycles to 18 megacycles in four bands. Two additional spot check points are available at 50 and 100 megacycles on positions 5 and 6 of the band switch. A meter which may also be used to indicate the condition of the batteries is used to provide visual indication of signal level. A jack is provided for the use of the headphones provided, or a loudspeaker which is available as auxiliary equipment. The sensitivity is rated at approximately 3 microvolts on all bands for one volt indication on the meter. An attachable rod antenna may be plugged into a radio or audio jack for tracing radiated signals or those of an induction field. Brackets are provided for fastening the antenna to the truck top. The weight of the instrument is 17 pounds.

Further information may be obtained from the manufacturer.

FIELD TESTS OF
RADIO INTERFERENCE LOCATORS

Field tests of three makes of interference locators have been made in order to determine their effectiveness in interference location.

Tests of the Tobe Deutschmann and Eltron locators were made on the system of the Central Virginia Electric Cooperative at Lovingston, Virginia, by the operating personnel of the system over a period of three months, and by members of the Technical Standards Division during the latter part of December 1949, on the system of the Prince William Electric Cooperative at Manassas, Virginia.

Tests of the Sprague instrument were made at Lovingston, Virginia and at the Clay Electric Cooperative, Keystone Heights, Florida during July and August 1950 by members of the Technical Standards Division.

A modified truck radio was used as a control piece of apparatus in the Manassas and Lovingston tests on all three locators, while a production receiver of the same type was used in the tests at Keystone Heights.

Results of these field tests indicate that for line patrolling the truck radio modified as shown in part II of this bulletin is the best solution to the noise location problem and that the portable units are best used as supplementary equipment to the truck receiver. They are useful in searching portions of line which are inaccessible by truck, and for use within the homes of consumers for locating the source of secondary noise complaints.

It is very difficult to eliminate ignition noise from the portable type of receiver unless the unit is completely shielded in a metal case bonded to the chassis of the vehicle, and the lead-in to the antenna brought in through shielded cable. The battery type miniature tubes are quite microphonic when subjected to the vibration in a truck and weak signals are easily masked by this noise. The Sprague Model 302 Locator incorporated a majority of the desirable features previously described, but was best used as supplementary equipment.

CONCLUSIONS

None of the instruments tested completely satisfied all of the requirements for an all

purpose location instrument. All of the portable instruments tested are best used as supplementary equipment to a good truck radio equipped with an output meter and a short wave converter.

Modification of one type of truck radio to adapt it to the solution of radio interference problems is described in Part II.

PART II

MODIFICATION OF A TRUCK RADIO FOR RADIO INTERFERENCE INVESTIGATION

The changes made in the circuit of the radio as described herein were made on the instrument as used in the test truck of the Technical Standards Division to adapt it to the solution of radio interference problems on rural power circuits. While these changes are for one specific model of a receiver, the principle can be used, with suitable modification of components, to adapt any make of truck or automobile radio. This work can be done by any competent radio technician who services automobile radios supplied by the local auto dealers.

Figure 1 shows the circuit diagram of the truck radio as supplied by the manufacturer, while Figure 2 shows the diagram of the radio with the changes. Referring to the diagram, Figure 1, the connection from the secondary side of the output IF transformer to the 1 megohm resistor (R42) is opened and a shielded lead connected to the resistor is brought out to the common leg of a single pole double throw switch. Another shielded line is run from the transformer secondary to the normally closed pole of the switch. A microswitch was used in the set as modified and the operating leaf of this switch was arranged so that insertion of the meter jack in the plug provided for the meter would cause the grounded sleeve of the plug to trip the micro-switch to position 2 (see Figure 2). The two resistors shown coming out of the load side of the last IF transformer are the 300,000 ohm volume control and a 330,000 ohm filter resistor.

Since these two resistors also act with the 1 megohm AVC filter resistor to provide minimum bias on the RF and IF tubes, by grid-leak action, a 670,000 ohm, 1/2 watt resistor was connected between switch position 2 and ground. When the meter plug is inserted in the meter jack, the microswitch disconnects the automatic volume control circuit and returns the tube grids to ground so that the circuit operation is normal except that there is no AVC action. Thus the switching is accomplished automatically. Mounting details of the microswitch are shown in the photograph in Figure 4 along with the meter jack which is mounted on the same small plate. A regular switch can be provided to do this switching although all leads to and from the switch should be shielded to prevent noise pickup on the open AVC lead.

Since the set may be used with a short wave converter, a small jack is mounted near the first one to supply B+ and filament voltage to the converter. Since the converter uses 180 to 200 volts as its B+ supply, a 5,000 ohm, 2 watt resistor is connected between the B+ bus and the supply jack to drop the 240 volt supply of the auto radio to the voltage required by the converter. This is the jack shown as J2 in Figure 2. It appears below the meter jack in the photograph in Figure 4, between the two tubes at the center of the chassis. The rear cover of the receiver is cut out in appropriate places to allow insertion of the plugs in the proper jacks.

The output meter, the instrument rectifier and the meter by-pass condenser are mounted in a small metal box which is provided with a hook for hanging the unit in the defroster vent on the driver or passenger side of the vehicle. The meter should be hung so that it is within the normal field of vision of the driver, but not within the windshield area, nor should it obscure the dash instruments. Photographs of the meter box, its cord and plug are shown in Figure 5. Figure 6 shows the rear of the meter box with cover removed, while the circuit diagram is shown in Figure 2.

The connections for the meter within the set are shown in Figure 2. The meter is coupled to the audio output tube through a 0.1 microfarad 400 volt paper dielectric condenser connected from the plate of the tube to the hot pole of the jack. When the meter is plugged into the jack, the grounded sleeve of the jack trips the microswitch so that the AVC action of the receiver is disabled at the same time that the meter is inserted.

When disconnected, the meter may be kept in the glove compartment of the truck and the radio functions as a normal broadcast receiver.

The converter as used on this set is the Gon-Set unit which tunes from 3 to 30 megacycles with an output frequency of 1500 kc. In use, the auto receiver is tuned to 1500 kc on its dial and the converter unit switched on. The tuning in the short wave bands is then done with the tuning knob of the converter.

Since details of the installation of the converter are covered in the instructions supplied with the unit, they will not be repeated here. Switching the converter off restores the auto set to normal operation as a broadcast receiver.

When short wave bands are added to the conventional auto radio by the use of a converter, it will be necessary to change the rectifier tube in the power supply if the 0Z4 type of rectifier unit is used. The 0Z4 generates quite a bit of power supply noise which is difficult to eliminate at the higher frequencies.

A 6X5 should be substituted for the OZ4, and since the connections are the same for either of these tubes no socket changes will be necessary other than completing the filament wiring for the use of the 6X5. Many sets come already wired for the use of either of these tubes in the power supply. The filament for this tube should be supplied from the green lead at the primary side of the vibrator transformer as shown in Figure 2 so that vibrator hash will not feed into the filament supply of the other tubes in the set and the converter.

The photograph in Figure 3 shows the complete assembly with the meter on the left, the radio in the center and the converter unit on the right.

Parts for the conversion will cost approximately $15.00 and can be obtained from any wholesale radio supply house. The cost of the converter is $39.50 and may be obtained from the same source. A complete list of parts is given on the page following the diagrams and illustrations.

The truck itself must be treated for elimination of ignition and wheel noise as well as for loose frame members which may create noise signals which will mask power line noise signals. Since the set will be operating at maximum sensitivity this may be a difficult problem. Graphite powder in the inner tubes and small spiral springs in the grease cups of the front wheels will help to eliminate tire noises. In some cases it may be necessary to drive in a small flat head brass wood screw on each side of the tire bead to ground the beading wire in the tire to the rim of the wheel. The hood should be bonded to the frame of the truck on each side through a bonding strap. The gen-

erator, starter, etc. and the voltage regulator should be by-passed with condensers made for this purpose. In extreme cases it may be necessary to move the antenna away from the engine compartment. Use of the new resistor type spark plugs will help to minimize plug noise. The ignition wiring under the dash should be dressed away from the antenna lead and from the shell of the converter and a by-pass condenser inserted in the load side of the ignition switch.

List of Materials Required

A. PARTS IN AUTO RADIO

C-1—0.1 microfarad 400 volt paper condenser.

S-1—Leaf actuated micro switch, Acro, SPDT.

J-1—Phone jack, short. Depth behind mounting panel not to exceed 1".

R-1—670,000 ohm, 1/2 watt resistor.

J-2—Socket, Jones type S-303-AB with three contacts. For power leads to the converter, should be mounted on a suitable plate inside the set and the back cover of the receiver cut away to provide access for the mating plug of the converter.

3 small solder lugs for connections to micro switch.

Mounting plate, 1/16" thick, approximately 1"x2" for mounting meter jack and micro switch.

Screws and hardware.

B. PARTS FOR METER BOX

Milliammeter—0-1 MA, 3" square, Triplett No.327A or equivalent. 2 3/4" diameter body hole required.

Cabinet—Metal, box, 4" x 4" x 2" with top and bottom panels. Bud Cat. No. Cu 883.

PL-1—Phone plug with nickel shell and cable clamp. Mallory No. 75A or equivalent.

R-2—Resistor, carbon 22,000 ohm, 1 watt, I.R.C. B.T.A. 5% tolerance.

C-2—Condenser, paper, 0.5 microfarad 200 volts dc.

Strip—Terminal, four point for mounting resistor, and meter rectifier.

Rectifier—Instrument, Conant Type B.H.S. or equivalent.

Cable—3 1/2 feet, microphone, shielded rubber covered, Belden No. 8401 or equivalent.

C. PARTS FOR CONVERTER

Plug—Jones, with cable clamp to mate with socket above. Type P-303-CCT required.

R-3—5600 ohm resistor, wire wound, 2 watt. IRC type BW2 or equivalent. (This unit required for converter, but is installed in radio.)

Converter—Gon-Set 3-30 megacycle converter. An extra antenna plug is included with the converter. The regular antenna plug furnished with the auto radio must be transferred to the output lead of the converter unit and the converter plug soldered to the antenna lead for insertion into the converter unit. Switching off the converter switches the antenna directly into the automobile set.

The diagrams and photographs show complete details of the circuit changes. The components listed above may be obtained from:

Allied Radio Company
833 West Jackson Blvd.
Chicago, Ill.

Walter Ashe Radio Company
1125 Pine Street
St. Louis, Missouri

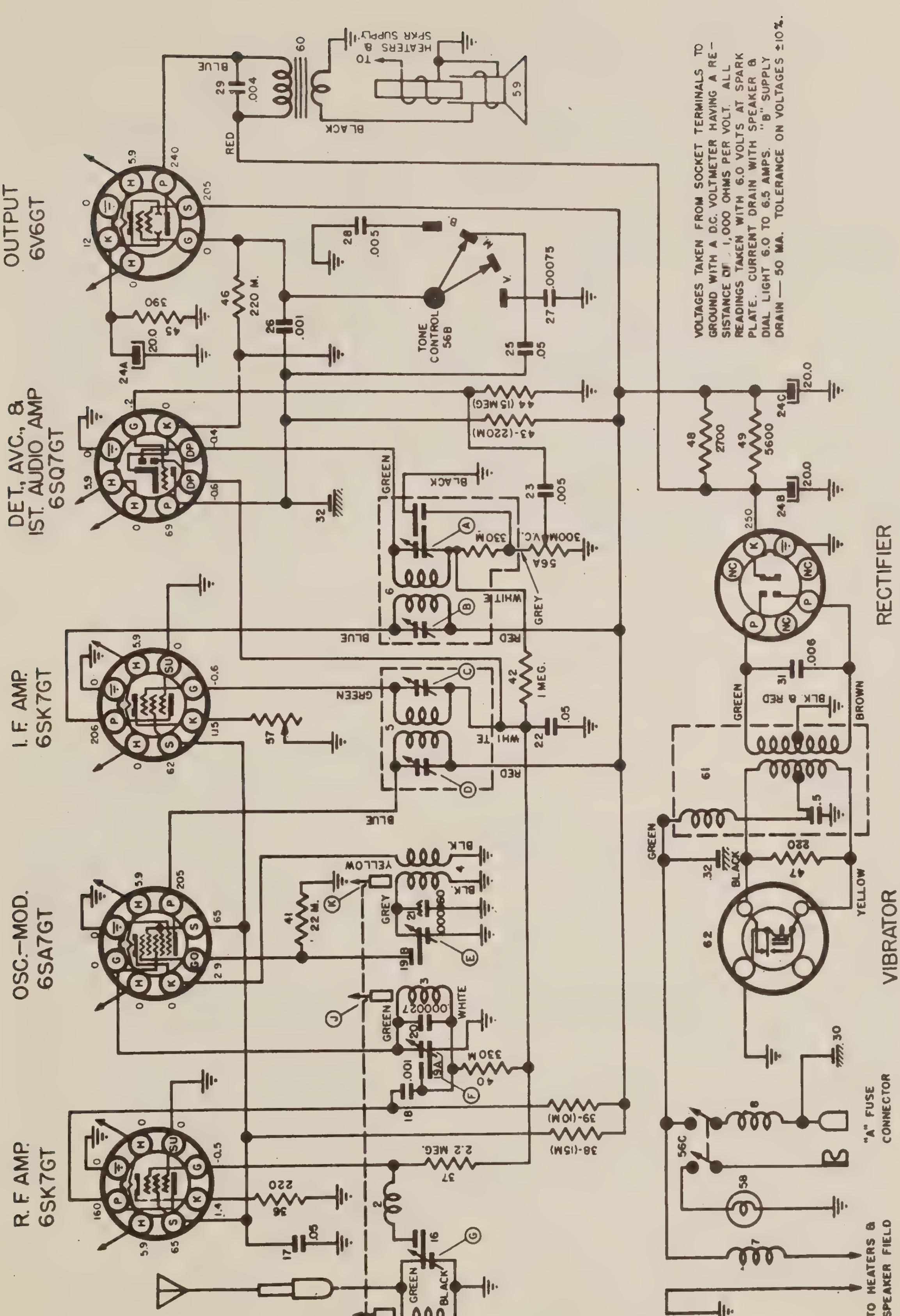
Any local wholesale supply house in your area.

PRECAUTIONS

All leads between the converter and the set should be kept as short as possible to prevent noise pickup from the ignition wiring in the truck.

When using the truck radio as a locator, the volume control should be advanced to a point which will give about 25% of full meter deflection. This will be a comfortable listening level for average types of noise.

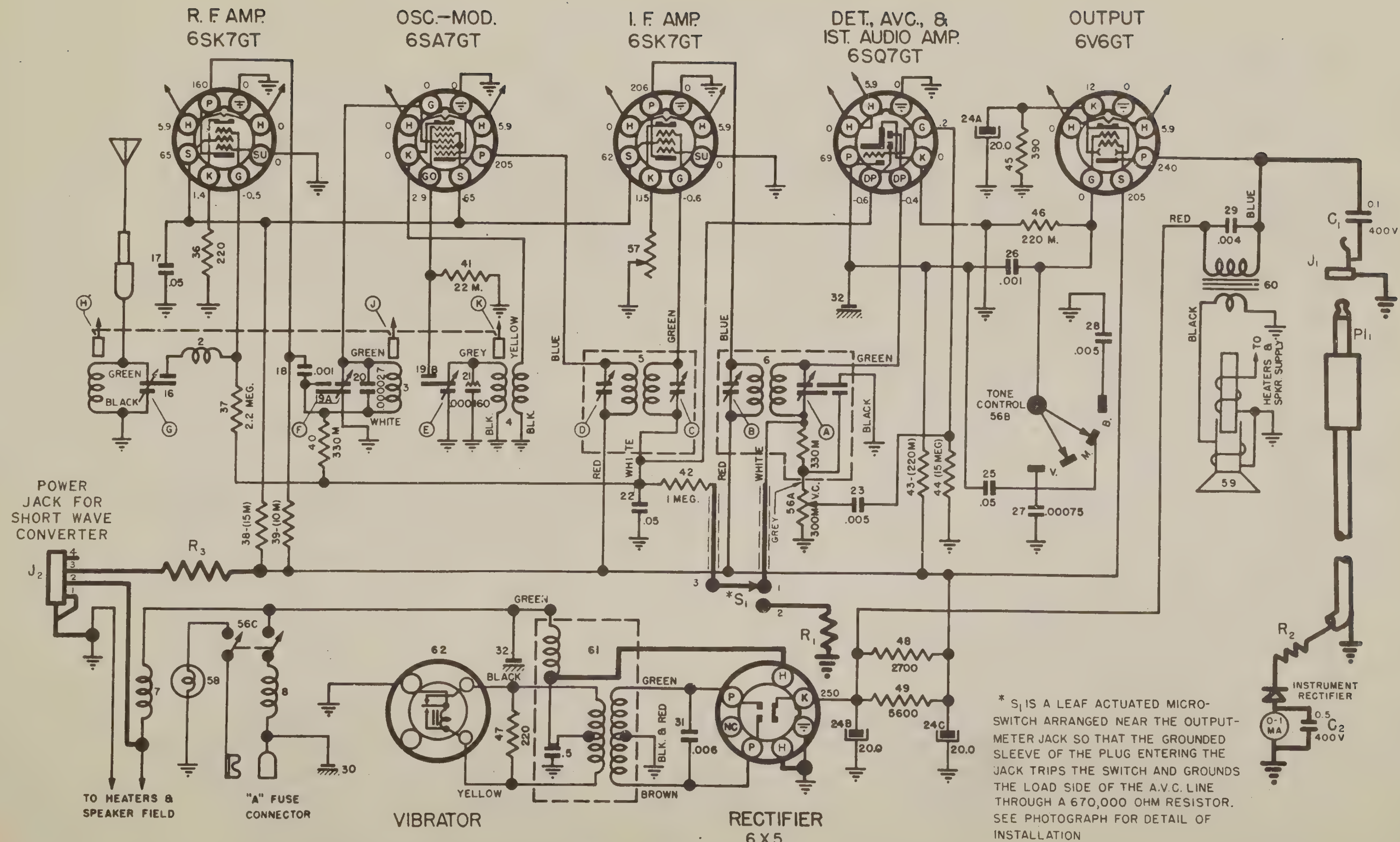
It must be remembered that since the AVC circuit has been made inoperative, the sensitivity of the set has been greatly increased and the set may overload on strong signals. This will cause distortion and mask the characteristic sound of the noise signal. The antenna should be shortened to reduce the input signal. In cases of extreme overload it may be necessary to adjust the sensitivity control on the receiver. This control is a screwdriver adjusted potentiometer toward the rear of the receiver near the antenna input plug.



VOLTAGES TAKEN FROM SOCKET TERMINALS TO GROUND WITH A D.C. VOLTMETER HAVING A RESISTANCE OF 1,000 OHMS PER VOLT. ALL READINGS TAKEN WITH 6.0 VOLTS AT SPARK PLATE. CURRENT DRAIN WITH SPEAKER & DIAL LIGHT 6.0 TO 6.5 AMPS. "B" SUPPLY DRAIN — 50 MA. TOLERANCE ON VOLTAGES ±10%.

Fig. 1

CIRCUIT DIAGRAM—RADIO 986067 (TRUCK)
CHEVROLET



* S_1 IS A LEAF ACTUATED MICRO-SWITCH ARRANGED NEAR THE OUTPUT-METER JACK SO THAT THE GROUNDED SLEEVE OF THE PLUG ENTERING THE JACK TRIPS THE SWITCH AND GROUNDS THE LOAD SIDE OF THE A.V.C. LINE THROUGH A 670,000 OHM RESISTOR. SEE PHOTOGRAPH FOR DETAIL OF INSTALLATION

MODIFIED CIRCUIT DIAGRAM—RADIO 986067 (TRUCK)
CHEVROLET

Fig. 2

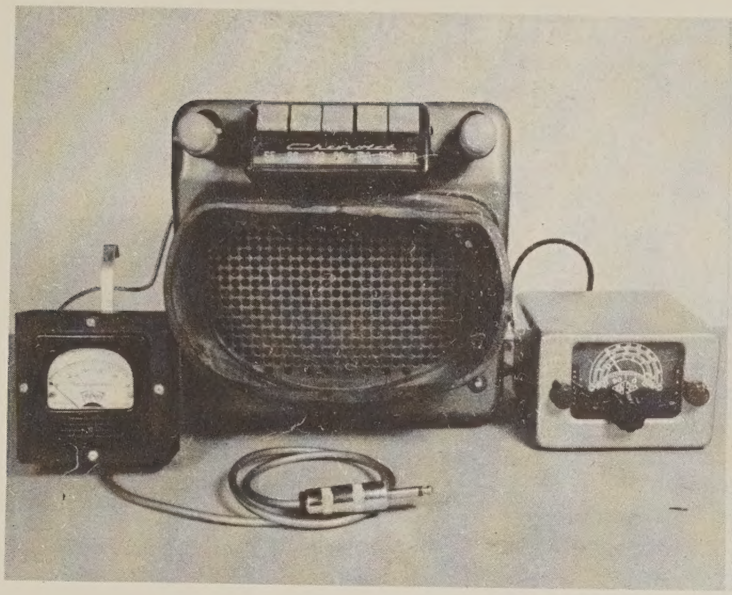


Figure 3
Meter, Receiver & Converter

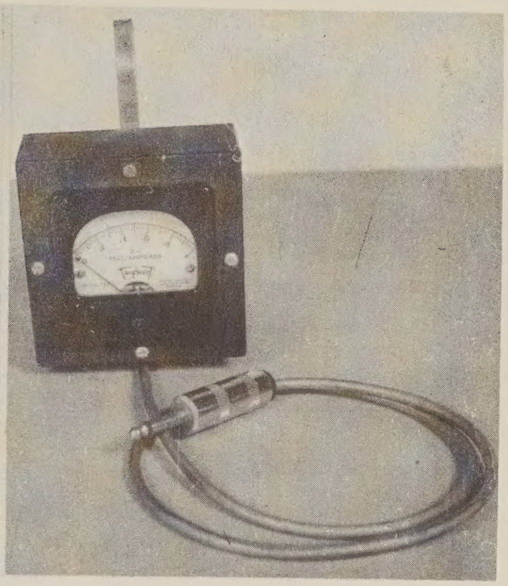


Figure 5
Meter and Box

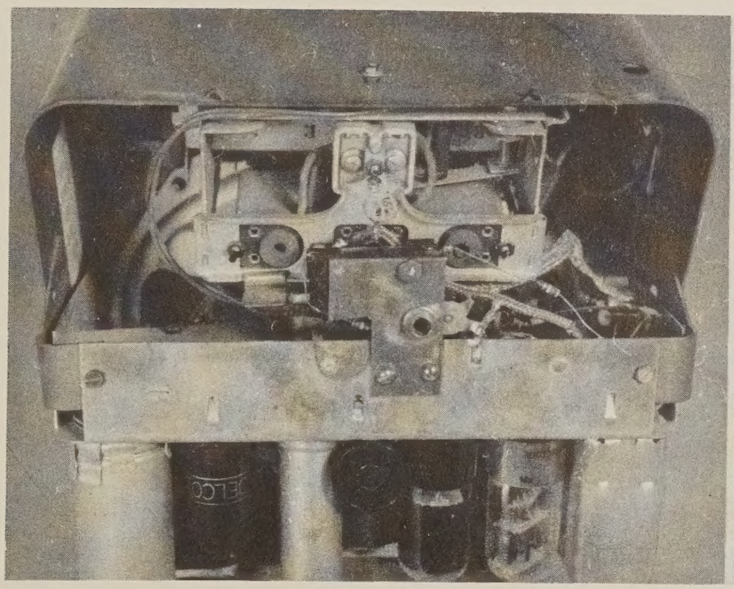


Figure 4
Detail of Inside of Receiver

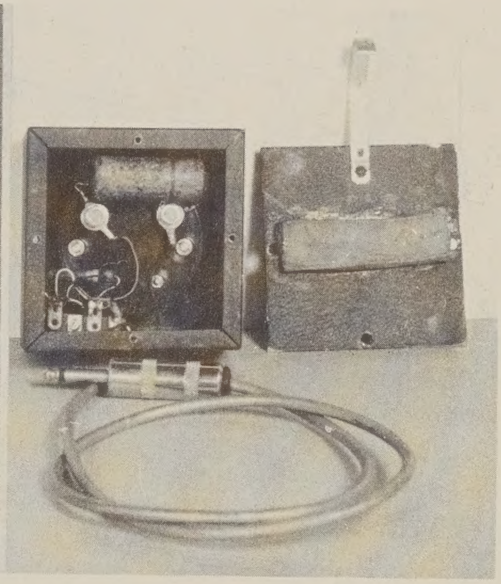


Figure 6
Rear of Meter Box
With Cover Removed